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July Coordinators Meeting

Randall Brown, DWR

On the morning of July 11, the coordinators met with Pat Coulston to discuss several issues regarding future program direction. A couple of the agenda items may of interest.

Boat Safety

Overall, the Interagency Program has had an excellent boat safety record, but there have been accidents. The coordinators agreed to develop an interagency boat safety program; efforts will be led by USBR staff reporting to the Management Team. The program will also include automobile safety from the time the field crew leaves and returns to their homes or offices. The need for a formal program has become more pressing with the deployment of several boats and crews as part of the real-time monitoring program. The goal is to have the program in place before the October directors' meeting.

Long-Range planning

We agreed to set up a small subset of the coordinators and manangement team members to help determine where the program should be heading for the next several years. Leo Winternitz will be collecting names for potential members, and I may chair the group.

Data Management

The coordinators agreed that the data management group has done a great job bringing the program into the information age — and in such a relatively short time. We also agreed that Karl Jacobs and Chuck Armor are to continue directing the work of appropriate staff to enhance capabilities of the intergency web site. Karl, Chuck, and staff are developing a pilot test of a relational database using much of the FWS salmon dataset.

Observations of Larval Smelt and Splittail in a Dry Year and in a Wet Year

Johnson Wang (National Environmental Sciences, Inc)

In 1995, California had near record high rainfall. High sustained flow that winter and spring provided unusual spawning conditions for resident fish, which contrasted sharply with conditions in 1994, one of the driest years on record. I looked at differences in abundance and capture location between the two year types for four fish species: longfin smelt, a native that spawns in brackish water; delta smelt, a native that spawns in either brackish or fresh water; wakasagi, an introduced fish that usually spawns in fresh water farther upstream than the delta smelt; and splittail, a native that spawns in fresh water.

There are two purposes of this preliminary examination:

- To describe the pattern and trend of the occurrence of fish larvae in a very dry year and very wet year to hypothesize how the fish respond to environmental changes.
- To look at existing information from various baseline studies to gain a better understanding of resident fish.

This could benefit the design of future studies. Interagency Ecological Program staff will be analyzing these and other data in more detail.

Major sources of information used in this study include:

- Egg and larvae samples collected by DFG in Suisun Bay, Montezuma Slough; the confluence and lower Sacramento and San Joaquin rivers; Chipps Island; Cache Slough and North Bay Aqueduct; and lower Mokelumne River. (DFG examined 2,368 samples in 1994; I considered data from sampling stations comparable to those used in 1995. In 1995, 1,169 samples were examined.)
- Egg and larvae samples collected by DWR in the central and southern delta (1994, 537 samples; 1995, 250 samples).

Supplemental samples include:

- USBR egg/larvae entrainment study at CVP in 1994 and 1995.
- DWR egg/larvae and juvenile fish studies at agricultural diversion sites in 1994 and 1995.
- DFG egg/larvae study at Liberty Island in 1995.
- DFG 20mm fish survey (by modified tow-net) in 1995.
- PG&E egg/larvae and juvenile fish studies near Chipps Island in 1995.

Longfin Smelt

Data for longfin smelt larvae collected in 1994 and 1995 are summarized in Table 1. In 1994 (dry year), the larvae were concentrated in Suisun Bay, below Chipps Island, from February to April. Some larvae were found in Cache Slough and in the central/southern delta. In 1995 (wet year, with high freshwater flow and low salinity), it appears that longfin smelt may have spawned mostly in San Pablo Bay in February and March. Larvae were found upstream in Suisun Bay and upstream into areas such as in 1994, but they were quickly pushed back into San Pablo Bay by the high flow. Hieb (1995a) found juvenile longfin smelt to be abundant in central and lower San Pablo Bay.

Fish species showing similar larval distribution to longfin smelt in 1994 were Pacific herring, northern anchovy, jacksmelt, yellowfin goby, and shimofuri goby. In 1995, Pacific herring, northern anchovy, and jacksmelt failed to show up in Suisun Bay and the delta; yellowfin goby and shimofuri goby invaded both Suisun Bay and the delta slowly and in much less abundance than 1994.

Delta Smelt

Occurrence of delta smelt larvae is shown in Table 2. In March-May 1994, larvae were abundant in Suisun Bay upstream to Cache Slough and the central-southern delta. Apparently, the center of spawning was near Rio Vista to the river confluence, including the lower San Joaquin River. In 1995, larval distribution patterns were rather obscure. In May-June 1995, small concentrations of larvae were observed in Suisun Bay below Chipps Island and in the lower Mokelumne River. Cache Slough, heavily used for spawning in 1994, was apparently used only marginally in 1995. However, information from other baseline studies (Winternitz 1995) indicates that early juvenile stages of delta smelt were far more abundant than the larval stages shown in Table 2.

What happened to this upside-down "pyramid" scenario? It is suggested that a small number of delta smelt larvae observed in Suisun Bay and the capturing of delta smelt larvae and early juveniles in the lower Napa River and upper San Pablo Bay (by modified tow-net) indicate that areas around Suisun Bay were likely delta smelt spawning grounds and that similar areas in San Pablo Bay such as the Napa River could be another part of the spawning ground.

Table 1
NUMBER OF LONGFIN SMELT LARVAE COLLECTED IN EGG/LARVAE SAMPLING PROGRAMS, 1994 AND 1995

	Suisun Bay/Confluence		Cache Slough/	Lower		
	Below Chipps Island	Above Chipps Island	North Bay Aqueduct	Mokelumne River	Central Delta	Southern Delta
1994						
February	4534	599	155	0	13	3
March	3742	1302	204	0	5	6
April	488	372	52	0	2	0
May	10	56	4	0	0	0
June	3	3	0	0	0	0
July	1	0	0	0	0	0
Total	8778	2332	415	0	20	9
1995						
February	848	117	27	1	4	0
March	498	127	32	1	0	3
April	56	5	2	1	5	0
May	0	0	0	0	0	0
June	4	0	0	0	0	0
July	5	0	0	0	0	0
Total	1411	249	61	3	9	3

Table 2
OCCURRENCE OF DELTA SMELT LARVAE, 1994 AND 1995

	Suisun Bay/Confluence		Cache Slough/	Lower		
	Below Chipps Island	Above Chipps Island	North Bay Aqueduct	Mokelumne River	Central Delta	Southern Delta
1994						
February	3	7	0	0	2	0
March	5	19	86	2	43	6
April	13	220	136	17	97	9
May	5	72	17	0	3	3
June	6	98	5	0	0	0
July	12	10	0	0	0	0
Total	44	426	244	19	145	18
1995						
February	0	3	1	2	1	0
March	2	7	9	0	1	0
April	3	4	4	16	2	0
May	21	10	1	27	3	0
June	48	9	9	4	0	0
July	6	4	3	0	0	0
Total	80	37	27	49	7	0

Wakasagi

Wakasagi is an introduced fish from Japan and is known to reproduce in this estuary (Wang and Brown 1993; Wang 1995). Wakasagi data are shown in Table 3. In 1994, a few larvae were observed in Cache Slough, whereas most of the catch (28 total) occurred upstream of Rio Vista to upper Sacramento River (Wang 1995). In 1995, 70 larvae were observed, concentrated mostly below Chipps Island and in Cache Slough in April and May.

Wakasagi larvae are known to occur above the usual spawning grounds of delta smelt, and delta smelt spawn at and above entrapment zone (Wang and Brown 1993; Wang 1995). In spring 1995, the entrapment zone was in San Pablo Bay (Knowles *et al* 1995), which further suggests that delta smelt spawning grounds might be linked to both Suisun Bay and San Pablo Bay. In 1995, wakasagi spawning grounds would be Suisun Bay and upstream.

During the 20mm modified tow-net survey, wakasagi were found in Suisun Bay and the entrance of San Pablo Bay. About 1 percent of the total smelt catch by the tow-net in summer 1995 was wakasagi. PG&E had a similar catch ratio of juvenile wakasagi (by Kodiak trawl) near Chipps Island from June to August, 1995. [Note that these identifications are visual keys and have not been confirmed by electrophoresis.]

Splittail

Occurrence of splittail is presented in Table 4. Although 1994 was a poor year for splittail spawning, a few larvae were observed in the study area and in the Sacramento River above Rio Vista (Wang 1996). In 1995, splittail larvae were abundant in all areas studied, particularly the southern delta. Splittail larvae were observed from February 11 through July 11, 1995, showing the most prolonged spawning period since 1988 (Wang 1996).

Like most of the other cyprinids, splittail is an opportunistic spawner. Judging by the similar measurement of larvae at all areas, peak spawning occurred in all areas in a close time frame in April. This massive spawn in attributed to fish from mostly the 1993 and older year classes. The 1995 splittail spawning conditions are believed to be "'once in a lifetime" event.

Juvenile splittail seem to have benefited from the high-flow year. They ware found in the San Joaquin River as far upstream as Mossdale (Winternitz *et al* 1995), where they were unknown from some previous studies (Meng and Moyle 1995; Wang 1996). They were observed in the lower Petaluma River of San Pablo Bay (Hieb 1995b). Seasonal movement of various life stages of splittail in 1995 seems to cover a much wider area than observed in 1994.

Other Species

Common carp, another cyprinid, also spawned successfully in 1995. A large number of larvae were found in Cache Slough, Liberty Island, and the southern delta (particularly Grantline Canal in early April).

Sacramento blackfish, also native to the Sacramento-San Joaquin system, had a good spawning year in 1995. Although larvae appeared to be far less abundant than larvae of splittail and common carp, this could be the result of sampling bias. In May and June 1995, Sacramento blackfish larvae appeared in the southern delta, Chipps Island, and Cache Slough (including the Liberty Island special study). Judging by the catch of juveniles in the southern delta (SWP, CVP, and San Joaquin River), 1995 could be the first year of significant spawning since the floods of the early 1980s.

Fish that experienced "flush-out" by the high flows in 1995 included the sturgeon *(Acipenser* spp.), Sacramento sucker, and even some American shad and striped bass.

In March and April 1995, sturgeon eggs were observed in the Cache Slough area, and yolk-sac larvae were found in Suisun Bay below Chipps Island. No sturgeon eggs orlarvae were taken in 1994 sampling. Juvenile sturgeon (mostly white sturgeon) were more common at the CVP and San Pablo Bay in summer 1995. According to Kohlhorst (1995), juvenile sturgeon grow faster and better in high-flow years.

In 1995, larvae of Sacramento sucker (an early-season spawner) were flushed out from the tributaries of the Sacramento-San Joaquin system. Juveniles were abundant at CVP and SWP salvage facilities in winter and early spring.

American shad eggs (as early as morula developmental stage) and larvae were observed in the Cache Slough and Suisun Bay areas in 1995. The eggs and larvae were abundant in the upper Sacramento River in 1994. Due to the high flows, juvenile American shad arrived early to the estuary in 1995. Juvenile shad were found near Chipps Island and in the southern delta for most of the summer, fall, and winter.

Conclusion

Some tentative conclusions can be drawn from examining four fish species in two extreme years:

Table 3
OCCURRENCE OF WAKASAGI LARVAE, 1994 AND 1995

	Suisun Bay/Confluence		Cache Slough/	Lower		
	Below Chipps Island	Above Chipps Island	North Bay Aqueduct	Mokelumne River	Central Delta	Southern Delta
1994						
February	0	0	0	0	0	0
March	0	0	0	0	0	0
April	1	0	4	0	0	0
May	0	0	1	0	0	0
June	0	0	0	0	0	0
July	0	0	0	0	0	0
Total	1	0	5	0	0	0
1995						
February	0	0	0	0	0	0
March	6	0	1	0	0	0
April	17	10	13	0	0	1
May	14	3	1	3	0	0
June	0	0	1	0	0	0
July	0	0	0	0	0	0
Total	37	13	16	3	0	1

Table 4
OCCURRENCE OF SPLITTAIL LARVAE, 1994 AND 1995

	Suisun Bay/Confluence		Cache Slough/	Lower		
	Below Chipps Island	Above Chipps Island	North Bay Aqueduct	Mokelumne River	Central Delta	Southern Delta
1994						
February	0	0	0	0	0	0
March	0	0	0	0	0	0
April	0	1	0	0	3	2
May	0	0	0	0	0	0
June	0	0	0	1	0	0
July	0	0	0	0	0	0
Total	0	1	0	1	3	2
1995						
February	1	0	2	1	0	0
March	25	9	9	1	0	1
April	27	23	24	18	21	195
May	10	3	5	5	1	12
June	3	0	6	0	1	4
July	0	1	5	0	0	0
Total	66	36	51	25	23	212

- During 1994 (dry year), longfin smelt larvae were observed in Suisun Bay, Cache Slough, and the central and southern delta.
- Delta smelt, wakasagi, and splittail larvae were found upstream of the entrapment zone.
- In 1995 (wet year), larvae were more abundant down-river and in Suisun and San Pablo bays.
- Most other resident fish responded in a similar dynamic pattern, but the fish community structure did not change that dramatically.
- In the dry year, more brackish-water-oriented fish invaded Suisun Bay and the delta. In the wet year, upper river and tributary freshwater fish moved down river to the delta (Table 5).

This information may be useful in designing future egg/larvae monitoring. In this regard, a flexible sampling scheme using quick feedback from sample analysis could help to track the larval population more efficiently.

Table 5
FISH LARVAE AND EARLY JUVENILES IN EGG/LARVAE SAMPLING, 1994 AND 1995

Fish Larvae Observed Only in 1994

1. Pacific herring
2. Northern anchovy
3. Plainfin midshipman
4. Jacksmelt
5. White Croaker
6. Cheekspot goby

Fish Larvae Observed Only in 1995

1. *Acipenser* spp.
2. Sacramento blackfish
3. Sacramento squawfish

Fish Larvae Observed in Both 1994 and 1995

1. *Lampetra* spp.
2. American shad
3. Shreadfin shad
4. Wakasagi
5. Delta smelt
6. Longfin smelt
7. Goldfish
8. Common carp
9. Golden shiner
10. Fathead minnow
11. Splittail
12. Sacramento Sucker
13. White catfish
14. Brown bullhead
15. Channel catfish
16. Rainwater reillifish
17. Western mosquitofish
18. Inland silverside
19. Threespine stickleback
20. Striped bass
21. Bluegill
22. *Lepomis* spp.
23. Largemouth bass
24. *Micropetrus* spp
25. White Crappie
26. Black Crappie
27. *Pomoxis* spp.
28. Bigscale logperch
29. Tule perch
30. Yellowfin goby
31. Longjaw mudsucker
32. Shimofuri goby
33. Prickly sculpin
34. Pacific staghorn sculpin
35. Starry flounder

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